September 21, 1992 CD-92-14 (LDV)

Dear Manufacturer:

Subject: 48 Inch Single Roll Electric Dynamometers

As you may be aware, EPA has signed a long term contract to acquire 48" diameter single roll electric dynamometers. Our ultimate goal is to replace all existing small twin roll hydrokinetic dynamometers at EPA's Ann Arbor facility. Obviously there are many steps which have to occur in such a conversion. My purpose in writing today is to inform you of our plans, address some underlying issues and to solicit your comments. I would also like to know your concerns regarding confirmatory testing on the new dynamometer during the transition period. Finally, EPA has scheduled a workshop for October 26, 1992, in Ann Arbor to discuss various technical issues associated with the use of the new dynamometer design.

Before proceeding further, I would like to restate our position on dynamometers used for manufacturer testing. Vehicle manufacturers may continue to use the dynamometer that best suits their needs. While most manufacturers currently use the same hydrokinetic dynamometer as EPA, that position is not universal. When EPA does convert to the new design, manufacturers will be required to maintain acceptable correlation. Establishment of dynamometer performance characteristics can facilitate correlation across different dynamometer designs.

Installation of the large roll electric dynamometer will hope to accomplish several things. First, the new dynamometer will be more reliable and repeatable; many of its features were specified with this goal in mind. Second, because it is electric and computer controlled, it can be programmed to match a vehicle's road characteristics over a wide speed range. (The existing hydrokinetic unit can only be set at one speed point, 50 mph; dynamometer loading at other speeds is a function of the dynamometers' internal characteristics and is not adjustable.)

Third, EPA believes that the large roll electric dynamometer will allow many dynamometer vendors to produce machines with equivalent performance.

The 48 inch single roll design has one other major advantage: it allows for a more representative simulation of actual road operation. The existing small twin roll design presents a rather severe and unusual operating environment, especially for front wheel drive vehicles with small tires. Although the forces exerted on a tire during small diameter twin roll dynamometer operation are not seen in actual road operation, the twin roll dynamometer must be considered by tire manufacturers in their design process. Changing to the large single roll dynamometer should greatly reduce (or eliminate) the dynamometer as a constraint on tire design.

EPA's first 48 inch dynamometer will be installed this fall. After initial checkout, a test program will be run comparing the old and new dynamometers. Upon completion, EPA will publish the results and propose a process of conversion for EPA confirmatory testing. With the installation process in the very early stages a firm timetable is impossible. Our best estimate is that the dynamometer will be available in December 1992, with the test program completed in March 1993.

I am enclosing a copy of our draft Dynamometer Evaluation Program for your review and comment. Any individual vehicle manufacturers or manufacturer organizations interested in loaning suitable test vehicles should contact EPA; EPA will require that any manufacturer "correlation" test results be publicly available.

The enclosed draft is the basic outline of the program we intend to run; I would appreciate your comments including the following topics.

> Stabilized test vehicles. Since we are using vehicles to evaluate dynamometer differences, stable emission and fuel economy characteristics are desirable. While some steps (such as disconnecting the evaporative emissions canister) may make a vehicle more "stable", such a vehicle would no longer be "representative". How should EPA proceed and what sort of test sequence (including vehicle prep) should be followed?

Coastdown data. Should each test vehicle receive a coastdown test or would information from a previously tested representative vehicle be adequate?

EPA's ultimate goal is to use the new dynamometers to simulate road force over a wide speed range during confirmatory testing. To accomplish this, changes in the procedure for determining and setting road force (Advisory Circular 55C) will be necessary. Several specific topics have been identified; I solicit your comments on these or other relevant issues:

Equation. Road force is currently described using a two term equation ($F = F_0 + F_2 V^2$). It appears that three terms ($F = F_0 + F_1 V + F_2 V^2$) may be necessary if road force is to be matched over a wider speed range. Should a three term equation format be adopted?

Speed Range. The coastdown test procedure specifies a 100 to 30 km/hr speed range. Should this be increased, or to what extent is extrapolation appropriate?

Temperature correction factors. Is there information available which could be used to update the tire rolling resistance correction factor? Is a single correction factor appropriate for all tires?

International Harmonization. EPA is aware that (some) European Common Market countries use a slightly different coastdown procedure. What changes could be made to reduce the amount of manufacturer coastdown testing? Should a revised procedure be written in metric?

Confirmation criteria. When EPA runs a confirmatory road coastdown test, how should the results be compared to the manufacturers' results and what tolerance would be appropriate?

Dynamometer setting. EPA does not foresee any great difficulty in setting the electric dynamometer to reproduce actual road force over an expanded speed range. However, we would appreciate any advice or comments from manufacturers with experience on this topic.

Tire Pressure. Because severe, abnormal tire deformation would otherwise occur EPA currently increases tire pressures to 45 psi for testing on the twin roll dynamometer. Since the large diameter single roll dynamometer presents a more "normal" environment, an increase in tire pressure may no longer be necessary. Manufacturer comments are requested.

During the transition period between dynamometer designs EPA will have capability to perform confirmatory tests on the twin roll dynamometer using current procedures or on the large roll dynamometer duplicating road load over a wider speed range. Since some manufacturers have, or will shortly have, large roll dynamometers at their own facilities, these manufacturers, in particular, may see an advantage in having EPA conduct (some) confirmatory tests on the new dynamometer. Other manufacturers may also wish to have their vehicles tested on the 48 inch dynamometer. In light of this I would like to know if manufacturers would prefer to have some, or all, of their vehicles tested on the 48 inch single roll dynamometer, adjusted to reproduce actual road force over an expanded speed range. Manufacturers would have to develop the actual road force relationship and supply EPA with the necessary information to set the dynamometer. EPA may allow manufacturers to request such testing if sufficient interest is shown and test capacity is available. Any manufacturer who may wish to have vehicles confirmatory tested on the new dynamometer should respond as soon as possible. EPA will, in the next few months, be making decisions on where the first few dynamometers will be located; i.e., certification test cells or elsewhere. EPA will attempt to adjust the installation sequence to meet the needs of vehicle manufacturers requesting such testing.

I would also like to ask your opinion on the best way to continue a long term dialogue on general dynamometer issues. Would cooperation between a technical or trade organization and EPA be acceptable to your firm and, if so, what organization? I would also like the name of a contact person for any vehicle-dynamometer issues specific to your firm.

As I mentioned in my opening paragraph, EPA has scheduled a dynamometer workshop for 10am to 4pm, October 26, 1992 at the Ann Arbor laboratory. Please inform us if your firm plans to attend and how many representatives will be present. (If the number of persons planning to attend is too large, we may need to relocate

the workshop offsite to a larger room.) We would like to have any initial written comments and suggestions for agenda items by October 15. EPA will summarize the comments and circulate an agenda prior to the meeting. While there are many relevant policy issues regarding the change in dynamometer designs, this workshop is limited to technical topics concerning the new dynamometer design and our proposed comparison program.

Please direct any questions or comments to Robert Larson of my staff; he can be reached at (313) 668-4277.

Sincerely,

Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

Enclosures

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Dynamometer Evaluation Program

Goal & Overall Approach

The purpose of this experiment is to evaluate differences between the large single roll electric and small twin roll hydrokinetic dynamometers when used on standard emission and fuel economy tests. To the greatest extent possible, steps will be taken to eliminate (or minimize) potential sources of variability due to factors other than these dynamometer differences.

The purpose of this test program is not to establish "correction factors." The experiment is designed to evaluate dynamometer differences by using the most diverse vehicles normally encountered in the certification program. Data collected will not be directly useful in deriving correction factors; if certain functions desired a supplemental program will have to be defined and run using a more "normal" vehicle population.

Evaluation Criteria

The function of a chassis dynamometer is to simulate the road force that a vehicle encounters in actual operation. (Ideally, the test vehicle would not "know" that it is on a dynamometer rather than the road.) The generally accepted method to determine vehicle force transfer is to equip the test vehicle with torque wheels; readings are taken periodically and the total positive work performed is then calculated.

Torque wheels can also be used for dynamometer comparisons. They are typically employed in laboratory correlation programs. To compare the small twin roll with the 48 inch electric dynamometer an analysis of both second by second and total integrated torque may be useful, assuming that appropriately equipped vehicles are available. Emissions and fuel economy (volumetric and carbon balance) will also be measured and used for comparison evaluation.

Schedule

This program will begin after dynamometer acceptance/check-out testing is completed, approximately December 1992. Completion is anticipated in March 1993.

Test Site

The first 48 inch dynamometer will be installed in dynamometer cell 5; this unit will share the same room as dynamometer 6, a small diameter twin roll hydrokinetic unit equipped with optional flywheels for medium duty testing. While each dynamometer currently has a CVS, it is proposed to use only one CVS to eliminate any potential bias. Each dynamometer site is currently served by the same analyzer bench.

Test Fleet

Vehicles selected represent a range of conditions: 1) vehicle weight, 2) rolling resistance, 3) aerodynamic losses and 4) drive axle loading. These variables should represent those parameters which will be important to dynamometer operation.

Following is a proposed test fleet representing the "corners" of our certification activity. The vehicles selected in most cases are not unique, i.e., a Ford Ranger could serve in place of the Chevy S-10. To reduce test variability vehicles should have automatic transmissions. Where possible, the vehicles selected should represent future technology engine and emission controls.

Vehicle	Description
	Civic HF low weight, low road load
	Grand Prix medium weight, low road load, high axle load
	S-10 medium weight, light axle load
Toyota cab chassis	 medium weight, high aero
	E250 heavy, high road load, RWD
	Deville heavy, "low" road load, FWD

Vehicles should be equipped with torque wheels and fuel flow meters. Procedures shall be used to assure that vehicles are "stabilized", including tire effects on the twin roll dynamometer.

Main Test Program

Each vehicle will undergo the following test sequence;

1. Cold start FTP (w/o SHED but with heat build?)
2. Highway Fuel Economy Test
3. Extended dynamometer and dynamometer verification

This sequence will be repeated on alternate dynamometers until the vehicle has been tested 5 times on each. The same driver shall be used for all tests on each vehicle.

Vehicles will be prepared for testing as required, tires will be stabilized for hydrokinetic dynamometer testing. Emission, wheel torque and fuel flow data will be collected.

If available, extended road coastdown data from the test vehicle will be used to set each dynamometer. The hydrokinetic will be set according to current procedure, the single roll electric will be adjusted to reproduce road force from 60 to 20 mph (as predicted by a three term equation.) Where track results on the test vehicle are not available, the manufacturer will be asked to supply the data used to develop the certification dynamometer settings.

A vehicle preparation sequence will be established to minimize test variability. Fuel needs will be evaluated and steps taken to assure that each individual vehicle is tested using the same batch of fuel. A decision will have to be made concerning vehicle fueling. Should the normal drain and fill FTP procedure be followed or should consumed fuel just be replaced? Would variability be reduced if the EVAP system were disconnected?